INTRODUCTION

- Variability in heartbeat timing, or heart rate variability (HRV), is used to assess the activity of the autonomic nervous system (ANS).1
- Changes in ANS function are reflected in HRV and result from lifestyle factors, aging, cardiorespiratory illnesses, and physiological stress.2
- Despite broad interest in HRV, few studies have characterized overnight HRV values or unobtrusively measured HRV during sleep in a large population.3
- Previous results have shown an age-related decrease in HRV in both an extensive sample of 20- to 60-year-old Fitbit™ wearers4 and a sample of 260 healthy individuals.5 Further, these studies showed that:
  - HRV declines with age for both men and women.
  - For individuals under the age of 50 years, the effect of male/female gender on HRV was mixed across the 2 studies.
  - The effect of gender on HRV disappears by age 50 years.4
- The standard deviation of normal-to-normal intervals (SDNN) is one of several types of HRV time-domain measures used to quantify the variability in measurements of time intervals in between successive heartbeats.1
- Normal-to-normal intervals are beat- beat cardiac intervals that represent normal cardiac timing and are free from artifact.2
- When measured for 24 hours, the SDNN may be used to stratify patients into different risk categories for cardiac-related morbidity and mortality.6
- To better understand population-level HRV changes, ecologically valid, overnight sleep SDNN values were analyzed for a large sample of Sleep Number™ smart bed users who provided electronic consent to be contacted to participate in scientific research.

METHODS

- Overnight SDNN values were obtained from Sleep Number™ smart bed recordings from home users in an ecologically valid research environment.
  - The time interval for SDNN measurement depended on the user and sleep session.
  - Heartbeat intervals used to compute SDNN were extracted from a ballistocardiogram (BCG; Figure 1).
  - BCG-based HRV measurement was previously tested in our laboratory for correlation with electrocardiogram (ECG)-based HRV, and these measures were found to be positively correlated, with a coefficient of determination (R²) of 0.50.

RESULTS

- Overnight SDNN values were obtained over the course of 18.2M sleep sessions from 379,225 users (48 ± 14.7 sessions/user).
- The study cohort was 50.9% women.
- The ages of the cohort ranged from 21 to 84 years and followed a normal distribution with a mean age of 52.8 ± 12.7 years old.

- Using a generalized linear model, statistically significant trends in SDNN were observed for several variables of interest: age (P < .0001), gender (P < .0001), and weekday vs weekend (P < .0001).
- The interaction of age and gender was significant (P < .0001).

CONCLUSIONS

- We used smart bed technology to measure overnight SDNN values unobtrusively among a large-scale set of users in an ecologically valid environment.
  - Our analysis revealed significant effects of age, gender, and day of the week on overnight SDNN values.
  - Starting at age 65 years, SDNN values increased with age.
  - This trend contrasted with previously reported SDNN levels for healthy individuals aged 65 years or older, whose SDNN levels decreased over time.4
- Differences in gender were apparent for some, but not all, age groups:
  - For those aged 40 years or younger, men had consistently higher SDNN values than women.
  - For those aged in their 50s, women had consistently higher SDNN values than men.
  - Weekend SDNN values were significantly higher than weekday values, suggesting that sleep may be more restorative in the absence of weekday stressors and time constraints.

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REFERENCES

6. The Sleep Number© Dream Map® System user manual (version 1.05).

DISCLOSURES

SB, KB, KS, and GGM Employees of Sleep Number Corporation.

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